

CLAIMS

1. A spatial information detecting device using intensity-modulated light comprising:

- 5 at least one photoelectric converter for receiving a light provided from a space into which a light intensity-modulated at a predetermined emission frequency is being irradiated, and generating an electrical output corresponding to an intensity of received light;
- a local oscillator circuit for outputting a local oscillator signal having a local
10 oscillator frequency different from the emission frequency;
- a sensitivity controller for mixing said local oscillator signal with said electrical output to frequency convert said electrical output into a beat signal having a lower frequency than the emission frequency;
- an integrator for performing integration of said beat signal at a
15 predetermined timing; and
- an analyzer for determining information about said space according to an output of said integrator.

- 20 2. The spatial information detecting device as set forth in claim 1, wherein said integrator performs the integration of said beat signal with respect to a plurality of integration ranges, each of which is determined within a given phase interval of said beat signal, and said analyzer includes determining a phase difference between the light irradiated into the space and the light
25 received by said photoelectric converter from resultant integrals of the plurality of integration ranges.

3. The spatial information detecting device as set forth in claim 1, wherein

said sensitivity controller comprises a semiconductor switch provided between said photoelectric converter and said integrator.

- 5 4. The spatial information detecting device as set forth in claim 1, wherein
said photoelectric converter generates, as said electrical output, amounts
of electric charges corresponding to the intensity of received light,
said integrator is provided with a charge storage for storing, as
signal charges, at least part of electric charges generated by said
10 photoelectric converter, and a charge ejector for ejecting the electric
charges from said charge storage in synchronization with said beat signal
having a frequency difference between the emission frequency and the
local oscillator frequency, and
said sensitivity controller has a function of modulating, at the local
15 oscillator frequency, a ratio of amounts of electric charges migrating to
said charge storage relative to the amounts of electric charges generated
by said photoelectric converter.
- 20 5. The spatial information detecting device as set forth in claim 4, wherein
said charge storage stores the signal charges of a plurality of ranges, each
of which is determined within a given phase interval of said beat signal,
and
said analyzer includes determining a phase difference between the light
25 irradiated into the space and the light received by said photoelectric
converter from the stored signal charges of the plurality of ranges.

6. The spatial information detecting device as set forth in claim 4, wherein

said sensitivity controller comprises a storage gate provided between said photoelectric converter and said charge storage to adjust amounts of electric charges migrating from said photoelectric converter to said charge storage.

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7. The spatial information detecting device as set forth in claim 4, wherein said sensitivity controller includes a charge discarding means for removing, as unnecessary charges, at least part of the electric charges generated by said photoelectric converter.

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8. The spatial information detecting device as set forth in claim 4, wherein said sensitivity controller comprises a storage gate provided between said photoelectric converter and said charge storage to adjust amounts of electric charges migrating from said photoelectric converter to said charge storage, and a charge discarding means for removing, as unnecessary charges, at least part of the electric charges generated by said photoelectric converter.

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9. The spatial information detecting device as set forth in claim 4, wherein said at least one photoelectric converter are a plurality of photoelectric converters,

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said charge storage of said integrator is a CCD (charge-coupled device) having a region of storing, as signal charges, at least part of electric charges generated by each of said photoelectric converters at a region corresponding to a gate electrode provided every photoelectric converter,

said charge ejector is a CCD for transferring the signal charges from said charge storage to outside,

said charge discarding means is formed with an overflow drain for discarding at least part of electric charges generated by each of said
5 photoelectric converters in a batch manner according to an external signal,

said photoelectric converters, said charge storage, said charge ejector, and said charge discarding means are mounted on a single semiconductor substrate to obtain an image sensor, and

10 said sensitivity controller is at least one of said gate electrode and said charge discarding means.

10. The spatial information detecting device as set forth in claim 4,
15 wherein said at least one photoelectric converter are a plurality of photoelectric converters, and said photoelectric converters, said charge storage, said charge ejector, and said charge discarding means are mounted on a single semiconductor substrate so as to provide, as a whole, an interline transfer CCD image sensor having an overflow drain.

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11. The spatial information detecting device as set forth in claim 4, wherein
said at least one photoelectric converter are a plurality of photoelectric
converters, and said photoelectric converters, said charge storage, said
25 charge ejector, and said charge discarding means are mounted on a single semiconductor substrate so as to provide, as a whole, a frame transfer CCD image sensor having an overflow drain.

12. The spatial information detecting device as set forth in claim 9, wherein said image sensor has a light shielding film on regions of storing electric charges and not relating to the generation of electric charges.

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13. The spatial information detecting device as set forth in claim 9, wherein said sensitivity controller is said gate electrode, and a voltage applied to said gate electrode is modulated by the local oscillator frequency.

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14. The spatial information detecting device as set forth in claim 9, wherein said sensitivity controller is said charge discarding means, and an external signal to be given to said charge discarding means is modulated by the local oscillator frequency.

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15. The spatial information detecting device as set forth in claim 9, wherein said sensitivity controller is both of said gate electrode and said charge discarding means, and each of a voltage applied to said gate electrode and an external signal to be given to said charge discarding means is modulated by the local oscillator frequency.

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16. The spatial information detecting device as set forth in claim 4, wherein said at least one photoelectric converter are a plurality of photoelectric converters,

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a set of photoelectric converters is selected from the plurality of photoelectric converters to define one pixel,

a plurality of sensitivity controllers corresponding to said photoelectric converters of the set are modulated by local oscillator signals having a same local oscillator frequency and different phases from each other, and

5 said charge ejector simultaneously outputs the signal charges corresponding to the different phases of said beat signal obtained by said photoelectric converters of the set.

10 17. The spatial information detecting device as set forth in claim 16, wherein said analyzer includes determining a phase difference between the light irradiated into the space and the light received by said photoelectric converter from the signal charges corresponding to the different phases of said beat signal.

15 18. The spatial information detecting device as set forth in claim 16, wherein said at least one photoelectric converter are a plurality of photoelectric converters,

20 said charge storage of said integrator is a CCD (charge-coupled device) having a region of storing at least part of electric charges generated by each of said photoelectric converters at a region corresponding to a gate electrode provided every photoelectric converter,

 said charge ejector is a CCD for transferring the electric charges
25 from said charge storage to outside,

 said charge discarding means is formed with an overflow drain for discarding at least part of electric charges generated by each of said photoelectric converters in a batch manner according to an external signal,

said photoelectric converters, said charge storage, said charge ejector, and said charge discarding means are mounted on a single semiconductor substrate to obtain an image sensor, and

said sensitivity controller is at least one of said gate electrode and
5 said charge discarding means.

19. The spatial information detecting device as set forth in claim 2,
wherein said analyzer includes converting said phase difference into
10 distance information.